Measuring Unfair Inequality in Brazil — 1995 to 2009*

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Abstract: This study measures unfair inequality in Brazil between 1995 and 2009. To do that, we used the statistical tool developed by Ålmas et al. (2010) and the concept of "responsibility-sensitive" fairness proposed by Bossert-Fleurbaey (Bossert, 1995 and Bossert & Fleurbaey, 1996). The results indicate that the fairness level in Brazil remained unchanged throughout the analyzed period. In conclusion, there was a sharp decrease in Brazilian income inequality, without any change in the unfairness level. It was observed that the unfairness level in Brazil is, at least, one and a half times higher than the levels obtained for developed countries.

Keywords: Income Distribution; Unfairness.

JEL-Classification: D31; D63; J31.

1 Introduction

Recent changes in the Brazilian economy, such as trade liberalization, price level stabilization and consequent development of a favorable environment for the adoption of income transfer programs, have been a key factor to the improvement of social indicators (e.g., income concentration, poverty, and welfare).[1] In other words, income inequality, which grew steadily between 1960 and 1990 (Barros & Mendonça, 1995), began to decrease remarkably and in a statistically significant way from the second half of the 1990s (Azevedo, 2007 and Figueiredo & Ziegelmann, 2009), leading to the improvement of poverty and pauperism levels (Ramos & Santana, 2003).

According to a strict egalitarian fairness ideal, the analysis of this scenario allows concluding that Brazil has become a fairer country. However, not even modern egalitarians, like Rawls (1971), Dworkin (1981), Arneson (1989), among others, regard the concept of perfect equality as an ideal parameter for fairness. Usually, the literature sees income inequalities as a function of different needs, efforts or preferences (Devooght, 2008).

A common criterion used in the literature assumes that individuals' outcomes are determined by "responsibility" and "nonresponsibility" factors (Roemer, 1998). In other words, part of an individual's income is considered to be the result of his effort, for example, investment in human capital, also known as "responsibility" factors; other part of the income is conditioned by circumstances, for example, social background, race, sex, region of birth, also known as nonresponsibility factors.

An indirect implication of this criterion is that only inequality that is due to differences in circumstances, or nonresponsibility factors, is socially undesirable. According to Devooght (2008), there are "offensive" and "inoffensive" inequalities.[2] Based on these arguments, the egalitarian rule is pushed to the back burner, giving rise to the "responsibility-sensitive" principle of fairness. The responsibility-sensitive principle asserts that economic and social policies must be addressed only to inequality due to circumstantial factors, letting individuals bear the consequences of decisions of individual nature.

Therefore, the relationship between continued reduction in Brazil's income inequality and greater social justice is drawn into debate. Disregard for inoffensive inequalities is likely to steer the country into a rather unfair scenario.

In order to check this hypothesis, this study aims to measure the level

[1] Most of these changes occurred after the second half of the 1990s. For further details on income distribution and poverty, see Neri (2006).

[2] A criticism about this view is that inequality is not necessarily "offensive" or "inoffensive;" it can be just spurious. For this argument, see Formby et al. (1989).

of unfairness in Brazil between 1995 and 2009. To do that, the statistical methods for determination of unfair inequality developed by Ålmas et al. (2010) are used, as well as the definition of the responsibility-sensitive principle of fairness proposed by Bossert-Fleurbaey (Bossert, 1995 and Bossert & Fleurbaey, 1996).

The analysis is organized as follows: a) first, the levels of unfairness for the initial year (1995) and final year (2009) are compared using the difference-based Lorenz curve, unfairness Gini index and the nonparametric test of stochastic dominance developed by Davidson & Duclos (2000); b) second, a set of unfairness indicators is devised for the 1995-2009 period. After that, it is possible to compare the evolution of income inequality and unfairness levels and; c) finally, two robustness checks are performed. The first one is based on the modification of the set of variables used to calculate the fairness rules whereas the second one is hinged upon the 1996 social supplement of the Brazilian National Household Survey (PNAD).

In addition to this introduction, the paper is organized into four other sections. Section 2 introduces the statistical methods, the criterion for determination of the fairness rule and the databases used in the study. Section 3 describes the results and Section 4 contains the final remarks.

2 Method and Empirical Strategy

This section introduces the statistical method for the measurement of unfair inequality developed by Ålmas et al. (2010) and the criterion for the determination of the fairness rule proposed by Bossert-Fleurbaey (Bossert, 1995 and Bossert & Fleurbaey, 1996). Finally, subsection 2.3 presents the databases used in the study.

2.1 The Difference-based Lorenz Curve and the Unfairness Gini Index

Consider strict egalitarian income distribution, that is, every individual should earn an income that equals the distribution mean. Thus, the level of unfairness of a given society is measured by the deviations of the income of each individual from the distribution mean.

To formalize this concept, consider a society A, with $N = \{1, ..., n\}$ individuals. Each individual $i \in A$ is characterized by a pair (y_i^A, z_i^A), where y_i^A is the observed income and z_i^A is the fair income. This way, $A = [(y_1^A, z_1^A), ..., (y_n^A, z_n^A)]$. As previously outlined, the level of unfairness is measured by deviations $y_i^A - z_i^A$.

Bearing in mind an egalitarian society, the fairness parameter is denoted by $z_i^A = \mu(A)$, with $\mu(A) = n^{-1}\sum_i y_i^A$. In other words, deviations of the observed income from the distribution's mean income, $u_i^A = y_i^A - z_i^A$, or $u_i^A = y_i^A - \mu(A)$ are considered to be unfair. In this case, one can use the Lorenz curve to assess the level of unfairness:

$$L(s; A) = \frac{\sum_{i=1}^{[ns]} y_i(A)}{n\mu(A)} = \frac{\sum_{i=1}^{[ns]} u_i(A)}{n\mu(A)} + s, \qquad 0 \leq s \leq 1. \qquad [2.1]$$

The main problem with this criterion is that it does not take into account the differences in merit among individuals, as the mean income is taken as a single rule. So, there could be some unfairness, i.e., two people can have different income levels because one of them put in a bigger effort. Therefore, adopting a single rule will punish the one whose effort was greater.

To circumvent this problem, Ålmas et al. (2010) suggest a generalization of (2.1). They propose that rules z_i^A capture the different levels of effort made by individuals. The starting point is the definition of the unfairness Lorenz curve:

$$L^U(s; A) = \frac{\sum_{i=1}^{[ns]} u_i(A)}{n\mu(A)}, \qquad 0 \leq s \leq 1. \qquad [2.2]$$

Note that (2.2) is identical with (2.1),[3] the only difference is in the definition of fairness. Ålmas et al. (2010) establish a standard axiomatic framework [4] demonstrating that (2.2) follows the same properties of (2.1). Based on their results, the authors derive an extension to an unfairness indicator, called unfairness Gini index:

$$G^U(A) = \frac{1}{2n(n-1)\mu(A)} \sum_i \sum_j |u_i^A - u_j^A|. \qquad [2.3]$$

Where the subscripts i and j indicate that the variable belongs to individuals i and j, respectively. In case of $z_i^A = \mu(A), \forall i$, (2.3) corresponds to the standard Gini index.[5] However, the core of the generalization is concerned with obtaining rules z_i^A. How is it possible to build them based on criteria that are sensitive to the level of effort of individuals? This issue will be dealt with in the next section.

[3]The constant s was omitted, as the normalization does not interfere with the comparison between the two Lorenz curves.

[4]Based on the axioms of anonymity, scale invariance, generalized Pigou-Dalton and unfairism.

[5]Calculated for $y_i \geq 0, \forall i$. The unfairness Gini index can also be calculated from $G^U(A) = \frac{2}{n(n-1)\mu(A)} \sum_i i u_i^A$, which simplifies the computational procedure.

2.2 Individual Fairness Levels

The results of the previous subsection indicate that it is possible to measure the unfairness levels by generalizing the standard Lorenz curve approach. Nevertheless, how can one build rules that capture the different levels of effort made by individuals in a given society?

To answer this question, it is necessary to assume that individual outcomes are determined by responsibility and nonresponsibility factors. The income differential from responsibility factors is deemed fair. On the other hand, income inequalities from nonresponsibility factors are defined as unfair. Thus, one can write the current income of individual i as a function of the responsibility, x_i^R, and nonresponsibility, x_i^{NR}: $y_i = f(x_i^R, x_i^{NR})$ factors.[6]

The distinction between these factors leads to an alternative definition of fair income levels. For instance, one could deem fair a situation in which income is distributed proportionally to each individual's claim, in which the claim is given by the value of the factor for which the individual is responsible. Or, according to Bossert (1995), Konow (1996), and Cappelen and Tungodden (2007), one could consider that an individual's claim is given by what would have been the average income in a hypothetical situation in which everyone had the same responsibility factors as this individual. Hence, an individual's claim depends on the nonresponsibility factors of all individuals in the economy, but only on the individual's own responsibility factors.

The criteria described in the previous paragraph are known, respectively, as classical proportionality principle and generalized classical proportionality principle. By adopting the latter one, one can define the claim of individual i, $g(x_i^R; \cdot)$ by:

$$g(x_i^R; \cdot) = \frac{1}{n} \sum_j f(x_i^R, x_i^{NR}).$$

Therefore, the fair income will be:

$$z_i = \frac{g(x_i^R; \cdot)}{\sum_j g(x_j^R; \cdot)} \sum_i y_i. \qquad [2.4]$$

Note that (2.4) determines the nonresponsibility factors, measuring the effort level of individual i in relation to the effort of other members of the society. Then, z_i stands for the share of the total income individual i should earn, given his proportional effort.

Empirically, $f(x_i^R, x_i^{NR})$ will be estimated using the log-linear specification:

[6] Hereinafter, superscripts A will be dropped.

$$\log y_i = \beta x_i^R + \gamma x_i^{NR} + \epsilon_i. \quad [2.5]$$

One of the problems associated with (2.5) is that it is not always possible to have nonresponsibility variables (x_i^{NR}), especially information on family background (schooling, income level and parents' occupation, for instance). Therefore, studies focus their inferences on responsibility variables (c.f., for example, Devooght, 2008, Ålmas, 2008, and Ålmas et al., 2010). To achieve that, they substitute (2.5) into (2.4), obtaining:

$$z_i = \frac{\exp(\beta x_i^R)}{\sum_j \exp(\beta x_j^R)} \sum_j y_j. \quad [2.6]$$

Given the problems with the endogeneity of the estimations of (2.5), which result from the non-independence between x_i^R, x_i^{NR} and ϵ_i (c.f. Bourguignon et al., 2007), combined with the lack of relevant nonresponsibility variables, one can consider (2.6) to be the upper bound of rule z_i.

Parameter (2.6) is built upon the following concept of fairness: population groups are defined according to their responsibility variables, and all within-group inequality is deemed unfair. This means that, if hours worked hours are regarded as the single responsibility variable, x_i^R, all individuals who work the same number of hours should have the same income level. Any income inequality outside this pattern is unfair (Devooght, 2008 and Ålmas et al., 2010).

2.3 Data

The data used in this study were obtained from the Brazilian National Household Survey (PNAD). This survey has been conducted by the Brazilian Institute of Geography and Statistics (IBGE) since the late 1960s and consists of a basic questionnaire that includes questions about household and personal characteristics, such as family size, household income, educational background, number of working hours, personal income, among others. In some years, some special characteristics are investigated and then summarized in supplemental issues. These special characteristics include, for instance, health, food safety, child labor and social mobility. The survey is conducted nationally, except for the rural areas of the northern region.

The first stage of the survey collects information on male household heads, or spouse, aged 25 to 65 years, who lived in urban areas of all Brazilian regions, except for the northern region, between 1995 and 2009 (note, however, that there is no available information for the year 2000).

The variables of interest were the following: a) the real income of all work;[7] b) years of schooling divided into four categories: E_1, low level of education, for individuals with up to four years of schooling (including illiterate ones), E_2, four to eight years of schooling, E_3, nine to eleven years of schooling and, E_4 for those with more than nine years of schooling; c) working hours; d) a migration dummy [8] and; e) experience, defined as age - years of schooling - 6.

The descriptive statistics for 1995 and 2009 are summarized in Table 1. Note that there was a rise in the mean income, followed by a decrease in working hours. In addition, the percentage of individuals with low educational level fell by eight percentage points. Conversely, category E_3 grew eight percentage points. These variables are used in the inference of equation (2.5) and, consequently, in rule (2.6). At this stage, all are regarded as responsibility variables.

Table 1: Descriptive Statistics: 1995 and 2009

	1995		2009	
	Mean	Std. Dev.	Mean	Std. Dev.
Income	1,543.17	2,356.35	1,680.17	1,423.19
Hours	46.82	11.97	45.48	11.96
Age	38.69	8.31	39.82	8.65
Education (%)				
E_1	42%	–	34%	–
E_2	27%	–	28%	–
E_3	19%	–	27%	–
E_4	12%	–	11%	–
Migration (%)	64%	–	56%	–
Sample	34,481		42,648	

Later on, the fairness rules are calculated using a set of responsibility and nonresponsibility variables. The data used at this stage are similar to those of Bourguignon et al. (2007). They include information collected by the 1996 PNAD social supplement. This supplement contains data on education, schooling and fathers' occupation of the surveyed individuals. Again, only male household heads or spouse aged 25 to 65 years who live in urban areas are included.

[7]Denominated in 2009 Reais as in the deflation method proposed by Corseuil & Foguel (2002).

[8]Defined as whether the observed municipality of residence is different from the one in which the individual was born.

The vector of nonresponsibility variables, x_i^{NR}, includes: a) a race dummy, which assumes value 1 for non-whites (i.e. black, brown and indigenous) and 0 for whites (whites and Asians); b) a region dummy, which assumes value 1 if the individual lives in Brazil's most dynamic regions (south, southeast and midwest) and 0 otherwise (north and northeast); c) fathers' education denoted in years of schooling,[9] and; d) father's occupation, according to the six categories proposed by Pastore & Silva (1999).[10]

The responsibility variables are represented by: a) years of schooling of the individual; b) a migration dummy and; c) his status in the labor market (formal worker, informal worker or own-account worker). Cohort dummies are also used. The first cohort represents individuals born between 1936 and 1940 (dummy variable C_1); the second cohort includes those born between 1941 and 1945 and so on and so forth up to the last cohort, which includes those born between 1966 and 1970 (dummy variable C_7). The sample contains 24,293 individuals. By taking into consideration the complex design, it is increased to 19,565,783 individuals.

Some descriptive statistics for this dataset are shown in Table 2, where information is split into responsibility and nonresponsibility variables. The first interesting fact concerns the higher educational level of children in relation to their fathers. The comparison between the mean schooling of fathers and mothers indicates that they are not significantly different. Note also that the number of migrants and formal workers is higher.

With respect to the remaining information, there is predominance of white individuals living in the country's most dynamic regions. As to parents' fathers' occupation, approximately 86% work in labor-intensive sectors with low human capital stock.

[9]Following the same classification suggested by Bourguignon et al. (2007): No school or incomplete 1st grade (0); incomplete elementary (2); complete elementary, or complete 4th grade (4); incomplete 1st cycle of secondary or 5th to 7th grade (6); complete 1st cycle of secondary or complete 8th grade (8); incomplete 2nd cycle (9.5); complete 2nd cycle of secondary (11); incomplete superior (13); complete superior (15); master or doctorate (17).

[10]Categories: 1) Lower Bottom: agricultural laborers, fishermen, lumberjacks, etc; 2) Upper Bottom: blue-collar workers, janitors, security guards, etc.; 3) Middle Bottom: masons, electricians, joiners, etc.; 4) Middle Middle: regional sales representatives, traveling salespersons, low-level managers, etc.; 5) Middle Top: consultants, high-level managers, CEOs, etc. and; 6) Top: large owners, magistrates, university-level professionals, etc.

Table 2: Descriptive Statistics: 1996 PNAD

Variables	
Mean earnings	1,655.36
Responsibility Variables	
Mean schooling	6.97
Migrants (%)	64%
Labor market status (%)	
Formal Employee	57%
Informal Employee	14%
Self Employed	29%
Nonresponsibility Variables	
Mean father's schooling	3.06
Mean mother's schooling	2.99
Race (%)	
White	61%
NonWhite	39%
Regions (%)	
North & North East	31%
South, South East & Center West	69%
Father's ocupational status (%)	
Lower Bottom	26%
Upper Bottom	34%
Middle Bottom	26%
Middle Middle	8%
Middle Top	4%
Top	2%

3 Results

This section presents and discusses the main results of this study. The analysis is carried out as follows: a) the earnings equations are estimated to obtain the parameters of the log-linear equation (2.5); b) then, rules (2.6) are calculated; c) finally, the unfairness level is inferred using the difference Lorenz based curves (2.2) and the unfairness Gini index (2.3).

First, in subsetion 3.1, the analysis focuses on the comparison between initial (1995) and final (2009) years. This allows investigating whether the unfairness level changed along the period. The statistical significance of a possible change is established by the nonparametric test of stochastic dominance developed by Davidson & Duclos (2000), applied to the difference Lorenz based curves of the selected years.

After that, a set of fairness indicators is developed for years 1995 to 2009. This allows comparing the evolution of income inequality and unfairness levels. Finally, in subsection 3.2, the analysis uses the 1996 PNAD social supplement and the criteria for determination of the fairness level, as proposed by Bossert (1995) and Kolm (1996).

3.1 Income Inequality and Fairness

The estimations of the wage equations, initial step for the construction of rules z_i, are carried out using quantile regressions (see Koenker, 2005), capturing the different impacts of covariates on earnings. The following deciles were considered: $\tau = 0.10, 0.20, 0.50, 0.80, 0.90$.

The estimation results for years 1995 and 2009, quantile $\tau = 0.50$, are summarized in Table 3. Note that all coefficients are significant at 1%. As a general rule, the comparison of both years shows that the parameters were not put through remarkable changes.

Note that unobservable variables rose in importance in the analyzed period, as the coefficient of R^2 drops from 0.10 to 0.06. This behavior can be interpreted as follows: given that the construction of the fairness rule considers that the unobservable factors (error term) are the nonresponsibility variables, a decrease in R^2 implies that these factors have a heavier weight in 2009 than in 1995. In other words, earnings density in 2009 depends much more on variables related to origin, color, and family background than on factors related to effort.

Figures 1 and 2 summarize the observed cumulative distribution functions (CDF) for the logarithm of earnings and the fairness rule. Note that there is no stark difference between the curves for the two sampled years, visually indicating that the unfairness levels of the Brazilian society (difference across ADF) remained unchanged. The difference-based Lorenz curves (Eq. 2.2), were estimated to confirm this suspicion. The estimates for 1995 and 2009, Figure 3, demonstrate that, even though the curve for 1995 is slightly larger than that for 2009 between quantiles 0.20 and 0.80, no remarkable change was seen in the unfairness level for the period.

The visual analysis, albeit elucidative, is not definitive. It is necessary to run a test that determines the statistical significance of the difference (equality) of both curves. The nonparametric test developed by Davidson & Duclos (2000) was then used. The test statistic, 0.4540, indicates that the null hypothesis of equality between the curves cannot be rejected at a 1%

Table 3: Earnings Equations – 1995 and 2009

	1995		2009	
	Quantile 0.50			
	Coef.	Std. Dev.	Coef.	Std. Dev.
Hours	0.0039*	0.0005	0.0051*	0.0004
Migration	0.1698*	0.0135	0.1015*	0.0101
Exper1	-0.5933*	0.0763	-0.5854*	0.0527
Exper2	0.0428*	0.0067	0.0454*	0.0047
Exper3	-0.0010*	0.0002	-0.0016*	0.0001
Exper4	0.0001*	0.0000	0.0001*	0.0000
E_1	-0.5226*	0.0093	-0.2839*	0.0084
E_2	-0.0763*	0.0107	-0.0606*	0.0060
E_3	0.4931*	0.0126	0.2586*	0.0083
Constant	8.8471*	0.2743	9.2672*	0.2159
R^2	0.10		0.06	
Sample	34,481		42,648	

Note: $^*p < 0.01$.

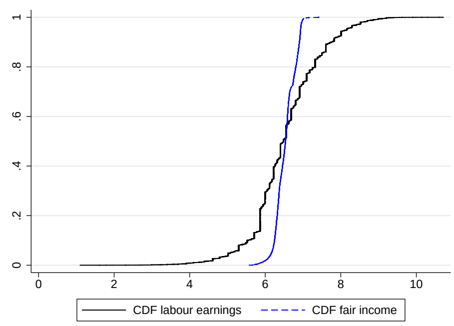

Figure 1: CDF: Fair Income and Labor Earnings – 1995.

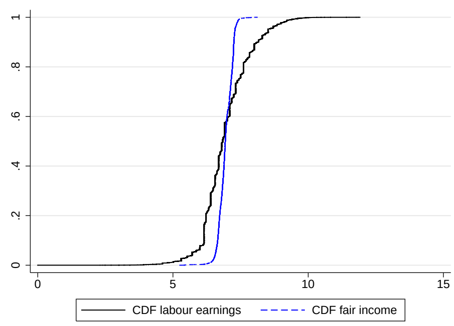

Figure 2: CDF: Fair Income and Labor Earnings – 2009.

significance level. Therefore, it can be concluded that the year 2009 has the same unfairness level as 1995.

To obtain a cardinal measure of the unfairness level, the unfairness Gini index was calculated. The analysis is similar to the earnings Gini index. Values closer to 1 mean greater unfairness.

Figure 4 and Table 4 show the evolution of the unfairness Gini index for the years between 1995 and 2009, except for 2000, when the PNAD was not applied. As with the analysis of the initial (1995) and final (2009)

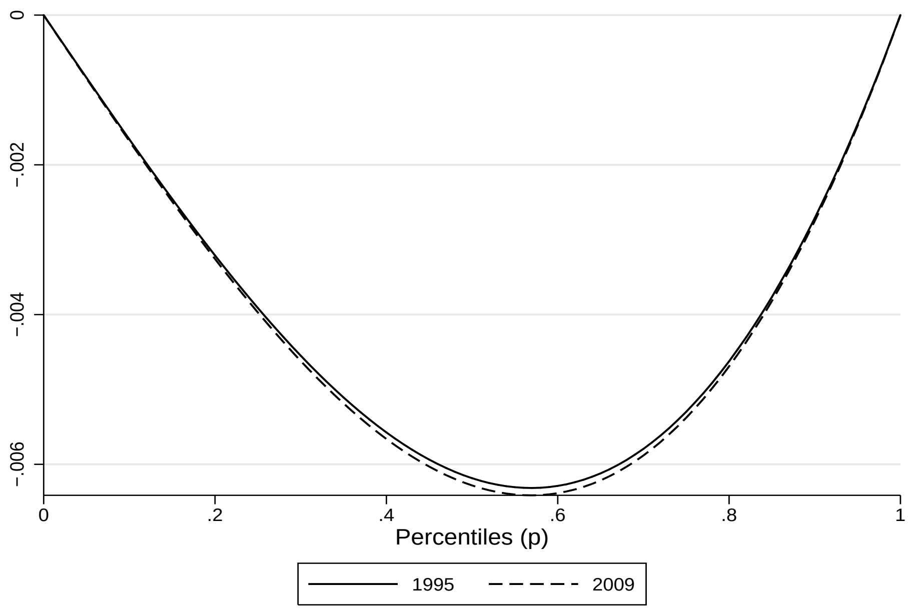

Figure 3: Difference Lorenz Based Curves: 1995 and 2009.

years, it was necessary to estimate the earnings equations, fairness rules and the difference-based Lorenz curves for each year. The values for the unfairness Gini index and the estimates for total income inequality (standard Gini index) are also shown.

The first interesting finding is that the total income inequality level fell by approximately 6% (from 0.5481 in 1995 to 0.5183 in 2009). This percentage might seem negligible, but in terms of inequality, it represents a substantial reduction. Amongst the 75 countries for which there is information about the evolution of inequality, less than 25% showed such a decrease (Figueiredo & Ziegelmann, 2009).

Moreover, the use of parametric and nonparametric tools, adopted by Figueiredo & Ziegelmann (2009), confirm the statistical significance of this change, which is consistent with a higher level of social welfare. However, does smaller inequality lead to higher fairness? As previously pointed out, the data indicate otherwise. The value goes from 0.4466 in 1995 to 0.4685 in 2009 - an increase of nearly 4%, which, according to the tests of stochastic dominance, does not allow stating that the values are statistically different.

Therefore, Brazil showed a significant reduction in income inequality in the analyzed period, but unfairness levels remained unchanged. Furthermore, although it is not possible to determine the statistical significance for unfair-

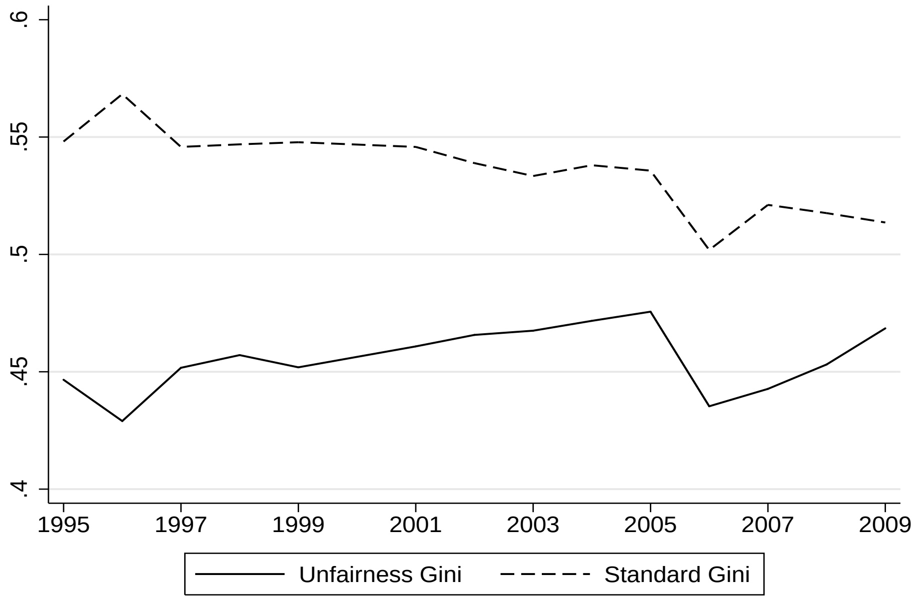

Figure 4: Inequality Levels: Unfairness Gini and Standard Gini – 1995-2009

ness movements, it cannot be denied that, unlike the income inequality level, the unfairness Gini index has an upward trend. From 1997 to 2005, for instance, income inequality and unfairness levels moved in opposite directions, that is, while the former dropped, the latter went up.

Indeed, this behavior was unexpected, as a more equal income distribution is necessarily believed to be fairer. Under a more specific approach, it could be stated that income transfer programs, implemented after economic stabilization, are efficient in reducing inequality and poverty levels, as advocated by Barros et al. (2001), but they do not eliminate unfairness. Or that other factors, usually neglected in income distribution studies, such as trade liberalization and price stabilization, also did not play a role.

The rationale behind this behavior might be in the fact that the design of Brazilian public policies (fiscal, educational, or income transfers) overlook fairness elements. These issues are not dealt with in the international literature, except in Roemer et al. (2003) and Aaberge & Colombino (2009), suggesting optimal fiscal policy models, contingent upon fairness levels (opportunities) with which individuals have to cope; Betts & Roemer (2005), investigating the role played by a reform in educational financing in racial and socioeconomic unfairness and; Fleurbaey & Maniquet (2011), analyzing the theoretical compensation models under the responsibility approach.

For now, the explanatory factors for the behavior of unfairness level in

Table 4: Inequality Levels: Unfairness and Standard Gini – 1995-2009

Brazil		
Year	Unfairness Gini	Standard Gini
1995	0.4466	0.5481
1996	0.4290	0.5683
1997	0.4517	0.5458
1998	0.4571	0.5469
1999	0.4519	0.5478
2001	0.4608	0.5458
2002	0.4657	0.5389
2003	0.4675	0.5334
2004	0.4717	0.5380
2005	0.4756	0.5357
2006	0.4353	0.5019
2007	0.4427	0.5211
2008	0.4531	0.5176
2009	0.4685	0.5136

Brazil during the study period will be put aside. The aim now is to establish a higher reliability for the estimates made in this subsection. The central question is: are the results sensitive to changes in responsibility variables? To verify this hypothesis, the difference Lorenz based curves will be inferred for years 1995 and 2009, considering different sets for (x_i^N).

Four frameworks will be adopted: a) Unfair1, considering only education variables such as (x_i^N); b) Unfair2, including education and working hours and; b) Unfair3, including education, working hours and migration. The idea is to observe whether the ranking of the difference Lorenz based curves, set up in Figure 3, changes. The estimation results are summarized in Figures 5 through 7.

The figures indicate that, regardless of the framework (responsibility cut) used, no change is perceived in the Brazilian unfairness pattern between 1995 and 2009. Again, the tests of stochastic dominance developed by Davidson & Duclos (2000) were applied, which, according to the test statistics (0.2573, 0.1098, 0.4563, respectively), confirm the equity in the curves.

3.2 Analysis with Responsibility and Nonresponsibility Variables

The results of this subsection will be based on an earnings equation containing information both on x_i^R and x_i^{NR}. The 1996 PNAD social supplement,

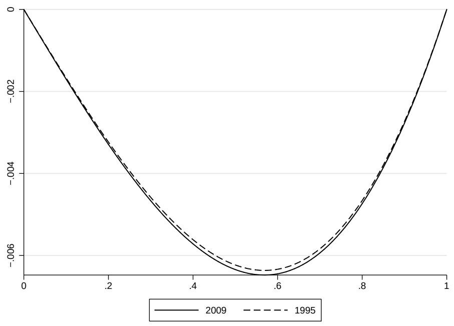

Figure 5: Difference Lorenz Based Curves: Unfair1.

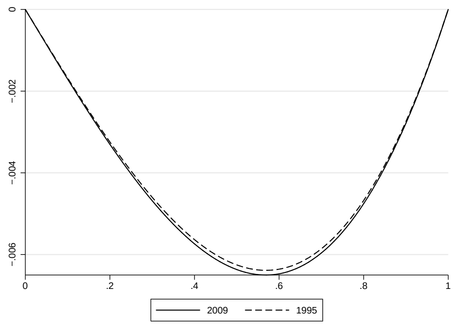

Figure 6: Difference Lorenz Based Curves: Unfair2.

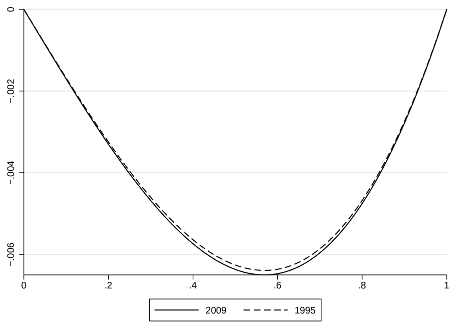

Figure 7: Difference Lorenz Based Curves: Unfair3.

and the *egalitarian equivalent* proposed by Bossert (1995), will be used for the calculation of fair income:

$$z_i^{EE} = g(x_i^R, \tilde{x}_i^{NR}) - \frac{1}{n}\sum_j (g(x_j^R, \tilde{x}_i^{NR}) - g(x_i^R, x_i^{NR})),$$

where $\tilde{x}_i^{NR}$ is the vector of nonresponsibility variables with fixed mean values. The empirical equation is given by:

$$z_i^{EE} = \exp(\beta x_i^R + \gamma \tilde{x}_i^{NR}) - \frac{1}{n}\sum_j (\exp(\beta_j x_j^R + \gamma \tilde{x}_j^{NR}) - \exp(\beta x_j^R + \gamma x_j^{NR} + \epsilon_j)).$$

The results for the earnings equation using the responsibility and nonresponsibility data are displayed in Table 5. Note that, as with the previous subsection, the estimations take into consideration the following deciles: $\tau = 0.10, 0.20, 0.50, 0.80, 0.90$. Again, only the quantile $\tau = 0.50$ will be introduced. The categorization of variables into responsibility and nonresponsibility follows the suggestion in Table 2.

The inferences that require generation of counterfactuals (equations that include the fixed mean values of nonresponsibility variables) will be made by a simple simulation process: to fix the nonresponsibility variables to the mean, an equation containing the individual's education as a function of nonresponsibility variables was estimated, establishing a "predict" variable. This new variable is included in the second stage of the estimation, in which income will be a function of responsibility variables (excluding education) and the "predict" variable.

Taking into account the parameters shown in Table 5, the fair income was calculated. The observed CDF for the logarithm of earnings and the fairness rule are shown in Figure 8. The unfairness Gini index, calculated using the difference Lorenz based curve, is 0.3350. When compared to the upper bound of this index for the year 1996 (0.4290), there is a difference around 26%, which is a considerable percentage value. However, using a similar exercise for the USA and Germany, Ålmas (2008) also obtains variation thresholds in the neighborhood of 26%. That is, as "responsibility-sensitive" criteria are disregarded, the unfairness Gini index converges to the standard Gini index. Conversely, i.e., by using a larger number of responsibility and nonresponsibility variables, these two measures are driven apart.

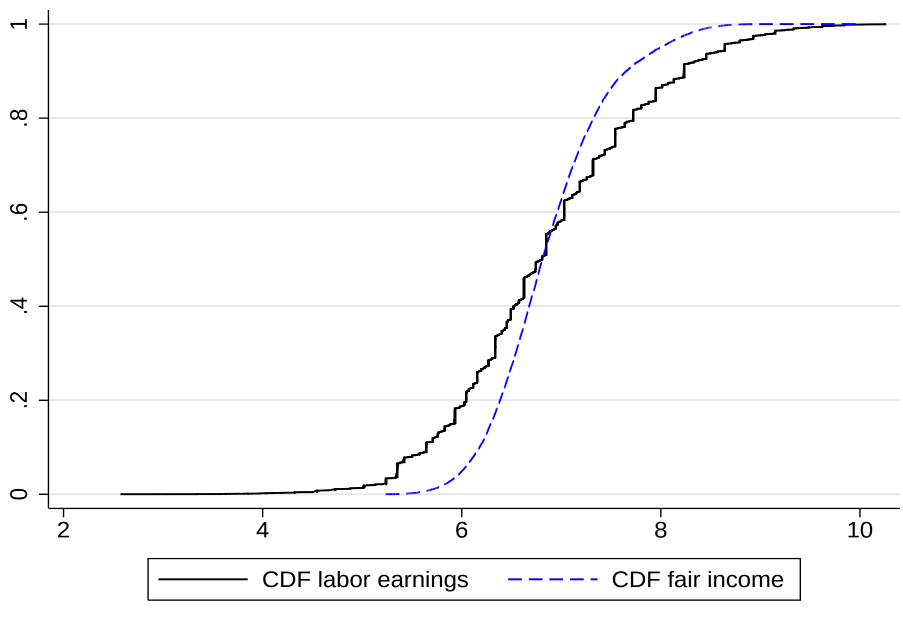

Figure 8: Distribution of Labor Earnings and Fair Income in 1996.

This way, it is possible to infer that the unfairness level in Brazil is somewhere around 0.34. This result is similar to the levels of inequality of opportunity calculated by Bourguignon et al. (2007) and Figueiredo (2011); however, these studies apply a distinct method for determination of inequality and use the Theil inequality index.

With regard to international comparisons, the results for the USA and Germany, described in Ålmas (2008), indicate that these countries, after controlled for responsibility and nonresponsibility factors, present an unfairness Gini index around 0.1850 and 0.2150, respectively. Again, the results obtained here are consistent, given that the literature demonstrates that the inequality of opportunity in Brazil is nearly twice that of the USA (see Figueiredo & Netto Junior, 2011).

4 Final Remarks

The aim of this study was to measure unfair inequality in Brazil between 1995 and 2009. To do that, the statistical tool developed by Ålmas et al. (2010) and the concept of responsibility-sensitive fairness proposed by Bossert (1995) and Bossert & Fleurbaey (1996) were used. The estimations focused on two datasets. In the first one, the fairness rules were built using a restricted set of responsibility variables from the PNADs for the years between 1995 and 2009. In the second one, the fairness rules were inferred from a set of responsibility and nonresponsibility variables, obtained from the 1996 PNAD social supplement.

The starting point for the construction of fairness rules was the estimation of log-linear wage equations. At that stage, nonresponsibility factors had a heavier weight in the determination of income along the years. In other words, income in the final (2009) year depends much more on variables related to origin, color and family background than on factors related to effort, when compared to the initial (1995) year.

Despite this finding, the comparison between fairness rules and the observed income suggest that the levels of unfairness did not change substantially in Brazil in the past 15 years. This result is confirmed by the calculation of the difference Lorenz based curves and by the nonparametric tests of stochastic dominance, which ratifies its statistical significance.

This scenario, combined with the sharp decrease in the standard Gini index, led to the conclusion that Brazil reduced inequality, but maintained unfairness unchanged. The robustness checks indicated that the adopted ranking was not sensitive to changes in the set of responsibility variables. Finally, the unfairness Gini index, calculated from a larger number of responsibility and nonresponsibility variables, hovered around 0.34, which represents virtually twice the unfairness inequality obtained for the USA.

In conclusion, it has been suggested that the maintenance of unfairness in Brazil at the same levels might be due to the fact that the fairness elements in the design of public policies were neglected. The literature shows the way (cf. Roemer et al. (2003), Betts & Roemer (2005), Aaberge & Colombino (2009), and Fleurbaey & Maniquet (2011)). So, a natural improvement of the present study would be the investigation of optimal policies under the responsibility-sensitive approach.

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Table 5: Earnings Equation – 1996

Variáveis	Quantil 0.50	
	Coef.	Std. Dev.
Education	0.1105*	0.0014
Migration	-0.1281*	0.0106
Age1	0.0453*	0.0116
Age2	-0.0003***	0.0001
Hours	0.0075*	0.0003
Educ. Father	0.0231*	0.0021
Educ. Mother	0.0125*	0.0089
Race	-0.1895*	0.0113
Regions	0.2376*	0.0118
Father's Occupation (Ref.: Lower Bottom)		
Upper Bottom	-0.0251***	0.0143
Middle Bottom	0.0553*	0.0154
Middle Middle	0.1208*	0.1478
Middle Top	0.1276*	0.0240
Top	0.2201*	0.0327
Cohort (Ref.: Cohort C_7)		
C_1	-0.3451*	0.1050
C_2	-0.1929*	0.0736
C_3	-0.0447	0.0501
C_4	-0.0142	0.0337
C_5	-0.0007	0.0227
C_6	0.0041	0.1103
R^2	0.30	
Sample	24,294	

Note: ***$p < 0.10$, **$p < 0.05$ e *$p < 0.01$.